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ROYAL GARDENS, KEW.

BULLETIN

OF

MISCELLANEOUS INFORMATION.

No. 25.] JANUARY. [1889.

LXXVI.—COCA.

Erythroxylon Coca, Lamarck.

Erythroxylon Coca, var. *novo-granatense.*

In recent years the well-known Coca plant has received considerable attention owing in a great measure to the valuable properties which have been ascribed to one of its alkaloids called Cocaine as a local anæsthetic. Coca wine and various other preparations of Coca leaves are now also largely in use. The plant itself has been noticed and described by botanists and travellers for more than three hundred years.

The earliest detailed account appears to be that given by Nicholas Monardes in the third part of his "Historia medicinal de las cosas que "se traen de nuestras Indias Occidentales que serven en medicina," which was published at Seville in 1580 after the author's death. This was translated into Latin by Clusius while delayed by adverse winds at Gravesend on his way to Belgium, where the translation was

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1889.

Price Twopence.

published at Antwerp in 1582. In 1580 an English translation of the third part, in addition to that of the two earlier parts previously printed, was also published by John Frampton, a London merchant. The Kew Library possesses a copy of this book, which is printed in black letter; its title is "Joyfull newes out of the newe founde worlde, wherein is "declared the virtues of hearbes, trees, oyles, plantes and stones." A condensed translation from the Spanish of the three parts is given by Clusius in his "Exoticorum libri decem," 1605, which is usually quoted as the earliest authority on Coca.

The account given by Monardes of the Coca plant and its uses is tolerably minute. He describes the characteristic areolation of the leaf to be presently alluded to. He says, in the "Leafe there is "marked an other leafe of the lyke forme, with a line very thinne: "they are softe and of a light greene." He also describes the methods of using Coca when travelling, either in the form of balls of a paste made by chewing the leaves with lime made from shells, or the leaves alone. "For the use of these litle Balls taketh the hunger and "thirst from them: and they say that they receuive substance thereby, "as though they did eate meate. At other times they use them for "their pleasure, although they labour not by the way, and they use "the same *Coca* alone, chewing it and tossing it in their mouths, from "one side to another, until there be no vertue remaining in it, and "then they take another."

The Coca plant, although generally known for some time previously to European botanists, was first defined as a species according to modern principles of nomenclature by Lamarck in the Encyclopédie Méthodique (1786), from specimens brought from Peru by Joseph de Jussieu. Cavanilles figured and described it from the same specimens, and we have also a representation of it in the inedited plates of Ruiz and Pavon. The first figure of the Coca plant published in this country appeared in the *Companion to the Botanical Magazine* (1836), vol. ii., t. 21, with a description by Sir William Hooker, from specimens gathered by Mathews in the environs of Chinchao, Peru. A full account of the uses and property, mode of cultivation and commercial value of Coca in its native country had been given previously in the same work (p. 161), in a translation from the second volume of Dr. Poeppig's *Reise in Chili Peru, und auf dem Amazonenstrome.*

At that time and for many years afterwards Coca leaves were looked upon merely as the source of a stimulant to the nervous system, employed by the inhabitants of Peru and Bolivia in very much the same manner and for the same purpose as the Chinese use opium and the East Indians chew the betle. The published statements from Monardes onwards respecting Coca appear to establish the fact that its use by the Indians of the Andean region enabled them to accomplish such severe labour as no European could perform. Von Tschudi refers to the effect the use of Coca had on himself, in greatly assisting respiration and in enabling him to ascend high mountains without fatigue. Dr. Weddell, Spruce, and Markham, and numerous other travellers and scientific observers agree in ascribing to Coca marvellous sustaining power, although many of them are careful to point out that Coca used in excess produces highly injurious effects, like the immoderate consumption of other stimulants or narcotics.

According to De Candolle the original home of the Coca plant in South America has not been clearly defined.* He states that early

* *Origin of Cultivated Plants*, Eng. ed., 1884, p. 136.

authors, such as Joseph de Jussieu, Lamarck, and Cavanilles, had only seen cultivated specimens. The specimens gathered by Mathews in the ravine of Chinchao might have been beyond the limits of cultivation. Those from Cuchero, collected by Poeppig, were said to be wild, although the traveller himself was not convinced of this. "It is by no means improbable," he says, "that the seeds may have been dropped by birds." André speaks of Coca in the valley of the river Cauca in New Granada as "in abundance wild or half wild." On the other hand Triana, a reliable authority on such matters, does not admit that the species is wild in New Granada. At present we have the Coca cultivated to a very large extent in the Andes of the Argentine Republic, of Bolivia, Peru, Ecuador, and the United States of Columbia (New Granada). It is also cultivated in the mountainous parts of Brazil, and there are specimens in the Kew Herbarium from the head-waters of the Rio Negro collected by Spruce in 1854. The largest plantations, called locally *Cocals*, are said to be in the province of La Paz in Bolivia. Weddell estimates in a good harvest the produce of Coca leaves per acre at about 900 pounds. The total production of Coca is something like 40,000,000 pounds, worth at 1*s*. per pound a value of 2,000,000*l*. Almost the whole of the produce is consumed in South America.

As might naturally be expected with a plant that has been long under cultivation, there have arisen many points of difference between the Coca plants grown in different parts of South America. These points of difference have been produced no doubt by seminal variation, influenced by diversity of soil and climate. They do not, however, except in one instance, amount to more than is observed in what botanists are accustomed to call geographical forms. Poeppig remarks that the appearance of the plants cultivated in Peru and Bolivia varies considerably, the under side of the leaf in the Bolivian plant being of a yellowish colour. Planchon and Triana (*Prodomus Floræ Novo-granatensis*, p. 337) also discuss the various differences exhibited by Coca plants, and even raise the question whether some of them may not be specifically distinct.

From Lamarck's description—"feuilles ovales-pointues"—it is evident that he had before him the plant with oval leaves, acute at both ends, which is characteristic of the Peruvian form of the species.* This is figured by Cavanilles (Diss. t. 229), by Ruiz and Pavon, and more recently by Sir William Hooker. Both by priority of description and by the high esteem in which the leaf is held, this must be accepted as the type. Figure 1, p. 4, reduced from the plate in the *Companion to the Botanical Magazine*, represents this.

Erythroxylon Coca, Lamarck.—A shrub or small tree 2–5 feet high, erect and moderately branched; bark usually reddish brown, passing in older specimens into greyish brown; branches scarred where the leaves have fallen off; young twigs smooth. *Leaves* chiefly on upper branches, alternate, soon falling, one to three inches long, lanceolate or oval, sometimes attenuated into the petiole, but in the type more or less acute at both ends, apex mucronate, perfectly entire, dark green above, paler and glaucous beneath, quite glabrous, mid-rib prominent beneath, lateral veins numerous, faint, freely anastomosing, the areolated portion slightly concave, paler and extending from base to apex on each side of the mid-rib; petiole from $\frac{1}{4}$–$\frac{1}{3}$ inch long; stipules small, closely pressed to the stem, and united along their inner edge to form a single triangular, acute, toothed organ, intrapetiolar (placed between the petiole and the

* Lamarck, Dict. ii., p. 393 (1786).

stem), very persistent, at first thin, greenish and transparent, becoming, on old branches, brown, stiff, and spinous. *Flowers* small, white, in-

Fig. 1.

Erythroxylon Coca, Lamarck.
1. Flower. 2. Ovary and stigmas. 3. Fruit.

odorous, on slender drooping glabrous pedicels, about $\frac{1}{4}$ inch long, several together in the axils of the leaves. *Calyx* very deeply cut into five triangular-ovate, acute, glabrous segments. *Petals* five, alternating with the calyx lobes, imbricate, with a broad claw, and a broadly oval-oblong, spreading, concave, obtuse limb, pale white or yellow, keeled at the back and somewhat plaited, with an erect, deeply bifid ligule at the junction of limb and claw, the two lobes crisped at the margin, with a reflexed tongue between them. *Stamens* 10, hypogynous, equal, as long or longer than the petals, erect, united at the base into a short fleshy tube surrounding the ovary; filaments white, smooth, anthers oblong, yellow. *Ovary* superior, ovoid, smooth, three-celled; styles three, erect, cylindrical, green, stigmas, capitate. *Fruit* a small indehiscent, red, smooth, drupe, one-celled, one-seeded by suppression, about $\frac{1}{2}$ inch long, oblong-ovoid, pointed, when dry, furrowed. Seed filling the endocarp, testa thin, embryo straight, with a superior radicle and flat cotyledons.

Other figures representing the type are given in Le Maout and Decaisne, *Botany*, (Hooker's translation), p. 295; and Baillon *Hist. des plantes*, pl. v., figs. 80–87.

Specimens representing this typical plant are in the Kew Herbarium from Mathews, No. 2023, collected at Chinchao, Peru; and from Mr. Pearce, collected also in Peru in 1867. A larger and bolder leaf than the type is found in a specimen collected by Mr. McLean in Peru, labelled "Coca from Titoc."

Leaves from specimens cultivated in Ceylon have lately been received from Dr. Trimen marked "from plants grown at an elevation of 1,500 feet;" also from specimens cultivated at the Botanical Gardens,

Demerara, at sea level, from Mr. G. S. Jenman. A plant of this typical form is now under cultivation at the *Jardin des Plantes*, Paris. The leaves in all these become more or less dark green, and even brown in drying. One of the most marked characteristics of the Coca leaf is the areolated portion, bounded by two longitudinal arched lines on each side of the mid-rib. These lines or ridges, which are more conspicuous on the under surface of the leaf, are caused by folds or creases produced by the mode in which the leaves are folded in the bud. The areolated portion is slightly concave, that is, more sunk than the rest of the surface, and slightly differing in colour. This peculiarity is not, however, confined to Erythroxylon Coca. It is very marked in another species,—*E. areolatum*, Poepp., and it furnishes a character for the section *Areolata* of De Candolle's Prodromus, vol. i. p. 575, in which five species are included. In many other species, where there are no demarcating lines, the leaves are sometimes marked by similar bud plaiting, or have a peculiar colouring circumscribing the same area. Next to the typical Peruvian plant the most distinct form which has come under notice in this country in a living state is one which appears to be very similar to the specimens collected by Triana in the Vallee du Magdalena in 1851–1857, and by Purdie at Sta. Martha in 1845, both in New Granada.

These specimens are characterised by the pale green colour of the leaves, by their obovate shape, obtuse or even emarginate, and perhaps more by the diffuse branching and leafy habit of the plant. A form possessing these characteristics has been under cultivation at Kew for more than 20 years. It was raised from seed, for which Mr. Abraham Dixon, who presented it to Kew (in 1869), was indirectly indebted to the Bishop of Huanuco. From this plant there have been produced some hundreds of plants, which have been distributed to numerous correspondents in different parts of the world. In many British Colonies this is the only Coca plant under cultivation, and it is therefore of some importance to give as much information as possible respecting it. Agreeing as it does in general characters with the New Granada specimens, it may be distinguished as:—

Var. *novo-granatense:* a leafy bushy plant, bark greyish brown, branches numerous and somewhat spreading (not erect as in type). *Leaves* usually smaller, 2 inches long, 1 inch broad, crowded, membranous, bright green above, paler and glaucous beneath, obovate-lanceolate, narrowly attenuated into the petiole, apex rounded, often emarginate with a small apiculus in the notch.

Bentley and Trimen, Medicinal Plants, vol. i., pl. 40; *The Garden*, vol. ix. (1876), p. 445, with woodcut. By the kind permission of the editor, W. Robinson, Esq., F.L.S., this is reproduced as Fig. 2, p. 6.

Specimens of this are in the Kew Herbarium collected in New Granada by Purdie at Sta. Martha in 1845, and by Triana at the Vallee du Magdalena, 1851–1857. Specimens from cultivated plants have been received from Mr. W. Fawcett, Jamaica, grown at 600 feet; from Mr. W. B. Espeut, Spring Gardens, Jamaica, grown at 100 feet; from Mr. John Gray, grown at sea-level, at St. Lucia, and others very similar from the Agri-Horticultural Society of India. All the leaves mentioned above are light green in colour, which is well preserved in drying; they are generally smaller than the typical Peruvian leaves, and approach very nearly (although not so coriaceous) as what are known in commerce as Truxillo leaves.

Intermediate to the above, both as regards the form and size of the leaf, are specimens in the Kew Herbarium collected by Spruce in 1854 on the Rio Negro. Cultivated specimens exactly corresponding to

these have been received from Dr. Treub, Buitenzorg Gardens, Java, grown at elevations of 820 feet, of 3,000 feet, and of 5,000 feet. Others

Fig. 2.

E. Coca, var. *novo-granatense.*

very similar have also been received from the Gardens of the Agri-Horticultural Society of India at Alipore and from Mr. Sackville Cresswell, Darjeeling, Bengal. These leaves may provisionally be adopted as exhibiting the general characteristics of Bolivian Coca.

The Culture and Preparation of Coca Leaves.

In the Andes the Coca plant succeeds best in the mild but very moist climate of the lower mountains, on elevations between 2,000 and 5,000 feet above the level of the sea. The thermometer at this elevation does not often fall below 60° Fahr., and the climate is free from any great or sudden changes. It appears that Coca, like Coffee, succeeds best on mountain slopes, where the soil is rich in humus, with perfect drainage. Swampy land is very unsuitable, and so also, according to Poeppig, is land strongly impregnated with lime. From the experience gained in cultivating Coca in other parts of the world, it appears that the plant thrives in warmer localities than were at first supposed to be suitable for it. In many tropical countries it will grow at sea-level, provided there is sufficient moisture in the air and the rains are pretty equally distributed through the year. It will not thrive at the higher elevations at which Coffee is grown in either the East or West Indies

An elevation midway between those mentioned above will probably prove most suitable, regard being had to the fact that the lowest minimum temperature does not fall below 65° Fahr. Shade is said to be unfavourable to the development of alkaloids in the leaves. Dr. Rusby has made repeated analyses of shade-grown and sun-grown leaves, with the result that the latter were invariably found much richer in total alkaloids. Plants appear to be generally raised from seed, and when 8 or 10 inches high they are put out in their permanent places during the rainy season. The care and cultivation suitable to tea or coffee plants would appear to be also those necessary to the cultivation of the Coca plant. The crop is a leaf crop similar to tea, and there would appear to be nothing special in the requirements of the plant, which is found to be hardy and easily managed.

In Peru plants begin to yield the first crop of leaves in three years after planting, but in poor soils the plants are often left until the fifth year. The full-grown shrub yields a harvest every 13 or 14 months, but as the ripeness of the leaves, which is proved by their breaking when taken in the hand and bent, depends very much on the soil and situation and the age of the plants, in many large plantations the collecting goes on throughout the year. In some favourable localities two or three good crops are gathered in the year.

In tea the very young leaves only are gathered. In Coca, on the contrary, the largest and most matured leaves are sought, as these latter contain most of the alkaloids which render the Coca leaves a marketable product. After being gathered the leaves in South America are usually dried in the sun on platforms; they are then heaped up to undergo a slight amount of sweating, and are then ready for use. According to Poeppig, if under peculiarly favourable circumstances the process of drying is accomplished in one day the leaves are esteemed the best, and are largely sought for, and fetch a high price. In this state the leaf is of a beautiful bright green colour, and quite smooth. The brown and less quickly dried leaves are cheaper.

As the result of analyses of sun-dried and shade-dried leaves which will be discussed later, it would appear that drying the leaves fully exposed to the sun is not so favourable for the production of Cocaine as drying slowly in shade. If leaves are artificially dried, the temperature, according to Dr. Warden, should not be much higher than 150° Fahr.

Now that Coca is being cultivated experimentally in other countries than South America, it is important to bear in mind that the standard of best Coca leaves is likely to change. "To a manufacturing chemist "the best quality would mean simply the quality that would yield the "largest percentage of crystallisable Cocaine, obtainable in the easiest "manner, while the same Coca might be considered for domestic con- "sumption (amongst the natives of South America) one of the lower "grades. It is highly probable that the amount of Cocaine forms no "element in the Indian's estimate of the quality of Coca any more than "the percentage of nicotine establishes the quality of a particular grade "of tobacco. Coca leaves are classed by the Indians as *Najas dulces* "(sweet leaves) and *Najas amargas* (bitter leaves). The former are "made sweet by the abundance of alkaloids other than Cocaine, while "in the latter the bitter flavour of Cocaine is the predominant one."*

Good Coca leaves unbroken are of a fine green colour and possess a delicate, agreeable, somewhat aromatic odour, which is specially perceptible when they are bruised, and which has been compared to the combined odour of hay and chocolate. Specimens are often met with in which the green colour is replaced by brownish yellow or reddish brown,

* Rusby in *Therapeutic Gazette*, vol. ii. pp. 15, 16.

and the odour lost, or more or less disagreeable. Coca when fresh has a somewhat grassy, aromatic, and slightly bitter taste, and when carefully dried it has a similar flavour, but in other cases its aroma is lost, and it is simply bitter and disagreeable.*

Chemical Notes.

As the value of Coca leaves outside of South America depends almost entirely on the amount of Cocaine yielded by them it has been considered desirable to supplement these notes by such chemical information as bears directly upon the cultivation of the Coca plant in various parts of the Colonies and India. In the preparation of this information we are indebted to Mr. Alfred G. Howard, F.C.S., F.L.S., grandson of the late Mr. John Eliot Howard, F.R.S., the well-known authority on Cinchona. By the aid of correspondents in the West Indies, Ceylon, India, and Java, numerous samples of Coca leaves grown in those countries were obtained with full particulars as regards the circumstances under which the plants were cultivated and the methods adopted in drying the leaves. These leaves were carefully analysed by Mr. Howard, and the results are of a very interesting character. They point out not only the best kinds of plants to grow, but also the circumstances best suited to produce a high per-centage of alkaloids, and the best methods for gathering and curing the leaves.

It is important to point out that the per-centages of alkaloids often quoted in regard to Coca leaves cannot be compared with one another, owing to different methods pursued in dealing with them. Mr. Howard states that the alkaloid determined in all his analyses "is simply "Cocaine in a pure state which is split up into crystallisable and "uncrystallisable Cocaine as nearly as could be done when working "with such small quantities."

The following analyses of Coca leaves, for convenience of reference, have been divided into four series :—

Analyses of Leaves of Coca.

Localities.	Per cent. Crystallisable.	Per cent. Uncrystallisable.	Total Cocaine.	Elevation.	Remarks.
				Feet.	
A.—Ceylon	0·60	0·00	0·60	2,300	Dried in the sun.
„	0·60	0·00	0·60	1,500	Dried in the shade } Grown at Botanic
„	0·47	0·00	0·47	1,500	Dried in the sun } Gardens, Peradeniya.
British Guiana	0·22	0·33	0·55	Sea-level	Dried in the shade.
B.—Java	0·30	0·09	0·39	820	Grown at Buitenzorg.
„	0·34	0·09	0·43	3,000	„ „ Sockaboemi.
„	0·24	0·08	0·32	5,000	Dried in the sun.
C.—Jamaica	0·33	0·43	0·76	100	Dried in the shade { Plants 6 months old;
„	0·24	0·16	0·40	100	„ „ sun { grown at Spring Gardens Estate.
„	0·25	0·33	0 58	600	Dried in the sun { Plants 5-6 years old;
„	0·20	0·45	0·65	600	„ „ „ { grown at Castleton Gardens.
St. Lucia	0·22	0·33	0·55	Sea-level	Dried in shade.
D.—India	0·45	0·35	0·80	900	Darjeeling.
„	0·27	0·23	0·50	—	Bogracote.
„	0·23	0·20	0·43	—	Alipore; dried in shade 10 days.
„	0·30	0·23	0·53	2,200	Ranchi, Chota, Nagpore.
„	0·41	0·17	0·58	2,200	„ „ „ dried in shade, then rolled and fermented like tea.

* Bent. and Trim. Med. Plants, vol. i. t. 40.

In the Annual Report of the Botanic Gardens, Ceylon, for the year 1887, Dr. Trimen, F.R.S., states that the Coca plants at Peradeniya and possibly all the plants now in the Colony have been derived from a Kew plant received in 1870. As there has been only one Coca at Kew such plants would necessarily belong to the variety *novo-granatense* (Fig. 2) already described. The specimens of leaves received from Dr. Trimen for analysis with his letter of the 27th February 1888 appear, however, to belong to the typical Peru plant (Fig. 1). They are in some cases 3½ inches long and 1½ inch wide; they are oval-pointed, dark green, and correspond very nearly with specimens collected in Peru by Mr. Pearce. The analyses of the Ceylon leaves show exceptional richness in crystallisable Cocaine; they have no uncrystallisable Cocaine and the total yield is the highest, with two exceptions, of any received. Of the two specimens grown at the Botanic Gardens, Peradeniya, it will be noticed that the leaves dried in the shade yield ·60 per cent. of Cocaine while the same leaves dried in the sun yield only ·47 per cent. Leaves grown in Ceylon at 1,500 feet, and 3,000 feet respectively show the same results. The difference of elevation has apparently not produced any effects on the yield in Cocaine.

The leaves received from British Guiana are not distinguishable in general characters from the Ceylon leaves. They are perhaps less coriaceous, but have the same dark green colour on the upper surface and are quite as large. The yield of Cocaine is somewhat less, but while in the Ceylon leaves there is no uncrystallisable Cocaine, in the British Guiana leaves the amount is ·33 per cent. If it should be proved that this is a highland plant it would not be likely to be so productive in alkaloids at sea-level in the tropics.

The Java leaves represent Coca grown at 800 feet, 3,000 feet, and 5,000 feet respectively. They belong to the intermediate forms provisionally classed as Bolivian with narrowly oblong leaves, pointed, dark green above and glaucous beneath. They contain chiefly crystallisable Cocaine, the results of the most favourable sample yielding ·34 per cent. crystallisable Cocaine and ·09 per cent. uncrystallisable Cocaine. The leaves grown at an elevation of 5,000 feet show a less favourable result than those grown at either 800 feet or 3,000 feet. This may be owing in part at least to the fact that they were dried in the sun. Mr. Howard states that the Bolivian leaves which usually reach this country from South America contain ·40 per cent. of crystallisable Cocaine and ·05 of uncrystallisable.

The plants grown at Jamaica and St. Lucia are characteristic of the variety *novo-granatense*. They are all apparently derived from the Kew plant. The leaves are obovate, blunt, or emarginate, and membranous, and of a light grassy green colour when dry. In one instance the total yield in Cocaine is exceptionally high. This occurs in leaves forwarded by the Hon. W. B. Espeut grown at Spring Garden Estate. The larger proportion of the Cocaine is, however, uncrystallisable. These leaves were from plants only six months old grown at nearly sea-level and dried in the shade. The same leaves dried in the sun appear to have lost ·36 per cent. of Cocaine. Leaves grown at the Castleton Gardens at an elevation of 600 feet, in perhaps less rich soil, yield ·65 per cent. of Cocaine, of which ·45 per cent. is uncrystallisable. A good series of such leaves were obtained from Mr. W. Fawcett, F.L.S. There is apparently a considerable difference in the yield of Cocaine in leaves gathered at different seasons in the year. This may account for the different yield of plants grown at sea-level in Jamaica and exactly

similar plants grown at sea-level at St. Lucia. In the one case the yield is ·76 per cent. of Cocaine, in the other it is only ·55 per cent. The general conclusion would point to the variety *novo-granatense* as being a lowland plant capable of growing in hotter conditions than those suitable to the type. Leaves taken from plants grown at Kew yielded ·44 per cent. of Cocaine, of which ·10 per cent. was crystallisable. Of leaves grown in India one sample forwarded to Kew by Mr. Sackville Cresswell, grown at Darjeeling at an elevation of 900 feet, gave the highest per-centage of total Cocaine, but a large proportion was uncrystallisable. The other leaves forwarded by the Secretary of the Agricultural and Horticultural Society of India have been already very fully discussed by Dr. Warden, M.D., F.R.C.S., in a *Note on Erythroxylon Coca grown in India*, published in Vol. viii., part iii., new series of the *Journal* of the above Society.

An interesting point connected with these leaves is brought out by Mr. G. Peppe, of Ranchi, Bengal. One set of leaves, dried in the sun, yielded ·53 per cent. of Cocaine, of which ·23 per cent. was uncrystallisable. The same leaves "dried in the shade on cloth for 20 hours, "then rolled by hand like tea, then fermented 2½ hours, dried over a "charcoal fire and put up in a closed tin box," yielded ·58 per cent. of Cocaine, of which only ·17 per cent. was uncrystallisable. These latter leaves were obtained from plants imported from Paris; the other Indian leaves were from plants introduced by the Agricultural and Horticultural Society of India. In general character they are all very much alike, approaching the Bolivian form perhaps in shape and colour, but evidently possessing the characteristics of Truxillo Coca in the high per-centage of uncrystallisable Cocaine contained in them.

The above results confirm the opinion already formed that there are several varieties of *Erythroxylon Coca* existing in South America, some of which have been now introduced into the Old World. These varieties have no doubt their own range of elevation at which they may be successfully cultivated, as well as characteristics more or less marked in the yield of crystallisable Cocaine.

The typical plant, Fig. 1, appears to be the best plant to cultivate at higher elevations, and if the object is to obtain a large yield of crystallisable Cocaine. The variety *novo-granatense* thrives at sea level in the tropics, and yields nearly, if not quite, as high a per-centage total Cocaine, but a large proportion of it under present chemical methods is uncrystallisable. The latter plant, judging from cultivated specimens in this country, appears to yield a larger crop of leaves than the type, but fruits somewhat sparingly.

As regards yield of crystallisable Cocaine we have apparently amongst Coca plants very much similar conditions as amongst Cinchona plants. In the latter, *Cinchona succirubra* yields a large proportion of total alkaloids like the variety *novo-granatense*, but only a small amount of crystallisable quinine. On the other hand, *Cinchona calisaya* (like the typical Coca plant) yields a smaller total of mixed alkaloids but a larger yield of crystallisable quinine.

Other Species of Erythroxylon.

There are numerous other species of Erythroxylon distributed throughout the inter-tropical regions of both hemispheres. The head-quarters of the genus is in tropical America, whence more than one hundred species have been already described.

The important properties which exist in the leaves of *Erythroxylon Coca* have naturally drawn attention to other species, in the hope that

their leaves might contain the same or similar principles. It is well known that the wood of numerous species is hard and yields a red dye. The young shoots of *Erythroxylon areolatum*, a native of Jamaica and of the northern parts of South America, are said to be a mild stimulant; the bark is a tonic, and the juice of the leaves is used externally against herpetic affections.

Erythroxylon monogynum (Sethia indica), a native of the East Indies, known under the Madras native name of *Gadara*, possesses a timber that is slightly fragrant, and Ondaatje records that a creasotic oil has been prepared from it. The leaves of this plant were used by the natives of India to mix with their food during the last famine.*

During the course of the present inquiry an effort has been made to procure as many samples as possible of leaves of various species of Erythroxylon in order that they may be analysed by the same method as that adopted for the Coca leaves. It might be naturally supposed that the two species already mentioned (*E. areolatum* and *E. monogynum*) which have gained a local reputation for medicinal properties would contain the larger amount of the characteristic Coca alkaloids. The leaves of *Erythroxylon areolatum*, grown at Jamaica, received from Mr. Fawcett, and dried in the shade contained ·035 per cent. of Cocaine, while similar leaves dried in the sun yielded ·023 per cent. of Cocaine. Leaves of *Erythroxylon Coca* from the same island have already been shown to contain ·76 per cent. of Cocaine,—so the quantity yielded by the indigenous plant is therefore only about one twenty-fourth part of that yielded by *E. Coca.*

No leaves of *E. monogynum* were obtainable for Mr. Howard, but reference may be made to an analysis undertaken by Dr. Warden of leaves obtained in Calcutta which "yielded ·04 per cent. of a principle "which, however, did not possess the physiological properties of "Cocaine."†

At the Botanical Gardens at Java Mr. Eykman, formerly Professor of Chemistry and Pharmacology at the University of Tokio, carried on researches into the properties of local species of Erythroxylon, which are fully borne out by the analyses of Mr. Howard with similar leaves sent to Kew by Dr. Treub. Mr. Eykman analysed the leaves of *Erythroxylon montanum*, *E. laurifolium*, and *E. retusum*. The amount of alkaloids found in them was in no case higher than one-tenth of that contained in the leaves of *E. Coca*. The bark of *E. montanum* and *E. retusum* contained an inappreciable amount of alkaloids, while the fruit contained only a trace.‡ The Java leaves analysed by Mr. Howard contained the following per-centages of alkaloids, *E. montanum* ·03 per cent., *E. laurifolium*, ·05 per cent., and *E retusum*, ·03 per cent.§ The highest per-centage reached by leaves of *E. Coca* received from Java (already noted) was ·43 per cent. Hence, according to these figures, the indigenous species yielded only one-ninth to one-fourteenth of the alkaloids yielded by *E. Coca*. Leaves of *E. macrophyllum* received from Mr. Jenman, Botanic Gardens, British Guiana, contained not a trace of alkaloids, while the leaves of *E. ovatum* yielded

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* Official Papers of the Government of Madras, Rev. Depart., 29th Sept. 1885, No. 1105.

† Note on *Erythroxylon Coca* grown in India by C. J. H. Warden, M.D., F.R.C.S., reprinted from Journal Agri.-Hort. Soc. India. Vol. VIII., Part ii.

‡ Annales du Jardin Botanique de Buitenzorg, Dr. M. Treub, Directeur. Vol. vii., Part 2, pp. 224–229. Leide, E. J. Brill. 1888.

§ Mr. Howard states that these results are not quite free from doubt. They are, however, very near those obtained by Mr. Eykman, and give almost identical proportions as compared with *E. Coca.*

·02 per cent. of alkaloids. This latter species is found in many of the West India Islands as well as in South America. It is known at Dominica as *Bois vinette*. A specimen in the Kew Herbarium, collected by Lechler in Peru in 1854, and named by Griseback *E. ovatum*, was marked "culta sub-nomine Coca, San Govan." From the character of this specimen there could be little donbt that it was only a form of *E. Coca*, and the amount of alkaloids contained in the leaves would have fully justified its being accepted as the true thing.

To summarise the results obtained from an examination of the leaves of local species of *Erythroxylon*, it is pretty clear that no species yet examined yields alkaloids at all comparable in quantity to those found in *E. Coca*. The bark of these species appears to contain even less than the leaves, while the fruit and seed contain only a trace of alkaloids. The following table will show the results as far as they are now obtainable. The yield of *E. Coca* is placed at the head of the list for comparison :—

Species.	Per-centage of Alkaloids.	Habitat.
Erythroxylon Coca - -	0·760	Grown at Jamaica.
„ areolatum - -	0·033	Jamaica; dried in shade.
„ „ - -	0·023	„ „ „ sun.
„ macrophyllum -	0·060	British Guiana.
„ ovatum - -	0·020	„ „
„ montanum - -	0·030 ?	Java.
„ laurifolium - -	0·050 ?	„
„ retusum - -	0·030 ?	„
„ monogynum - -	0·040	India.*

* Analysis of Dr. Warden.

Present Value of Coca Leaves.

Since the discovery of the anæsthetic properties of Cocaine the demand for Coca leaves in South America has considerably increased for export purposes. A distinct loss in the alkaloids generally, as well as in Cocaine, has been noticed during the transit of leaves to this country, and latterly, in consequence, it has become the practice to extract the alkaloids from the leaves in South America and export to the United States and Europe a crude preparation which is largely taken up by manufacturers of Cocaine.* The demand for Coca leaves has therefore fallen off, and it is probable that the cultivation of the Coca plant in our tropical Colonies may never assume large proportions. Small and exceptionally fine samples of Coca leaves may find a limited market in this country or on the Continent; and possibly in India and Eastern countries it may be worth while to grow sufficient leaves to meet the local demand for Cocaine. Beyond this it is scarcely possible to go, if it is borne in mind that South America is able without further extension of cultivation to produce such enormous quantities of Coca leaves, that the one-eightieth part would be sufficient to swamp the Cocaine markets of the whole world. In a letter dated January 25th, 1888, Messrs. Burgoyne, Burbidge, Cyrian, and Farries reported that the commercial

* This crude alkaloid contains about 70 per cent. of pure crystallisable Cocaine, and is selling for about 15*s*. per ounce.

value of "Coca leaves yielding total alkaloids of ·80 per cent. would "be about 6*d.* to 8*d.* per pound. At present it is difficult," they say "to get a true valuation on account of absence of demand . . . . . "The average price last year (1887) was about 8*d.* per pound, taken "all round." In a letter dated the 9th November 1888 Messrs. Burgoyne state "very few parcels of Coca leaves now come before us on "the market as the manufacturers of Cocaine either deal directly with "the shippers of the leaves or possibly buy the crude extract for manu-"facturing purposes. The demand for the alkaloid increases, and the "price of the leaves varies from 10*d.* to 1*s.* 6*d.* per pound. In the "absence of statistics of stock here we cannot say what the probable "future of the article is with regard to price." In a further letter dated the 5th December 1888 Messrs. Burgoyne kindly forwarded the following interesting information respecting Coca leaves in the United States: "We have just heard from New York that the stock of Coca "leaves in that city consists of 10,000 pounds of Huanuco leaves, and "40,000 pounds of Truxillo leaves. These were all imported this year, "and are good green leaves. The Huanuco leaves are the kind used for "making Cocaine, but since the large quantities of crude Cocaine "arrived from Lima on the European markets there has not been such "an active inquiry, and the price has declined to 22 cents (eleven-"pence) per pound. It is a well-knowu fact that they cannot be "imported under 26 cents (thirteenpence) per pound, and when the "small stock of 10,000 pounds is gone, higher rates will no doubt be "obtained for Huanuco leaves. The Truxillo leaves, on the other "hand, are only used in pharmacy and for Coca wine. They are as "strong as the other kind in alkaloid, but the product will not crys-"tallise. The stock in hand, viz., 40,000 pounds, is a large one, and "the price may probably go down to 15 cents [sevenpence half-"penny]."

LXXVII.—BEETLES DESTRUCTIVE TO RICE-CROPS IN BURMA.

Mr. Arthur E. Shipley, F.L.S., Fellow of Christ College, Cambridge, and Lecturer on Entomology at the Indian Civil Engineering College, Cooper's Hill, communicates the following report for publication in the *Bulletin* :—

On November 24th I received a collection of beetles from Burma preserved in spirit. The beetles were all of one species, and in an excellent state of preservation. As I was unable to be in London, I am indebted to my friend, Mr. W. F. H. Blandford, for a careful comparison of some of the beetles with the single specimen of the same species in the British Museum, and for some observations on the character of the species.

The name of the beetle is *Chætocnema basalis* (Stephens), and a description of it is given by Mr. J. S. Baly in the "Transactions of the Entomological Society of London" for 1877, p. 310. The beetle is there described as occurring in India.

The genus *Chætocnema* was established by Stephens, and covers almost the same ground as the genus *Plectrocelis* of Chevrolat.

In a letter accompanying the beetles, it is stated that they do much damage to the young paddy in the rice-fields of the Taungyas in the

northern part of the division of Tharrawaddy. The beetles appear in June when the paddy is about 6 inches high, and first attack the leaves, and then pass on to the stem and roots. The hill tribes or Karens in this district state the beetle has appeared before; but the Burmans are doubtful if this is the case. The natives call the insect *Wetpo.*

I am unacquainted with the methods of the cultivation of rice in Burma, and the life history of *Chætocnema bacalis* has still to be worked out, so that it is difficult to suggest any means of combating the pest. However, I have added a few remarks on the habits of the family *Halticidæ*, and of the means used in various parts of the world in dealing with insect pests of this family. I do not imagine that the latter will be of direct use in Burma, but they may possibly suggest some practical methods to anyone acquainted with the local features of the pest.

I understand that the rice in the Taungyas is grown by a dry method of cultivation; this would agree with the habits of the *Halticidæ*, which as a rule avoid damp or swampy places.

The fact that the beetle is well known to the Karens, and not so well known to the Burmans, is possibly owing to the beetle living in the hills and not descending to the plains.

The family *Halticidæ* contains a great number of species of minute beetles. The family is a very homogenous one, the difference between the various species being very slight. A common feature of the group is the adaptation of the posterior legs for springing, a feature which in conjunction with their minute size, has given rise to the popular name of *flea-beetle.*

As a rule the beetle passes the winter in the imago condition, and during the following spring the eggs are deposited in the under surface of the leaves of the plant infested by the beetles. The eggs take in temperate climates from 7 to 14 days to hatch, and the larvæ which then emerge are minute, linear, whitish grubs, with a black or yellowish-brown head. They are provided with six pairs of legs. The larvæ after existing for a longer or shorter period become pupæ.

The pupæ are white, and often enclosed in an earthen cocoon in the ground.

Many species have two broods in the year. The larval stage of the cycle of development is the one during which most damage is effected. The minute white grubs bore through the tissues of the infested plant, keeping between the upper and under epidermis of the leaves and devouring the soft mesophyllor intermediate layer. Sometimes, however, they devour all the tissue between the veins of the leaves, thus reducing it to a skeleton. The beetles also eat the leaves.

The following are some of the methods which have been successfully used in dealing with the injurious members of *Halticidæ.*

These beetles seem to have a great objection to dust which possibly gets between their legs and impedes their movement. Hence plants which suffer from the attacks of the *Halticidæ* are often protected by being sprinkled with any kind of finely divided matter which is itself innoxious to the plant. Amongst these substances powdered lime, soot, road-dust, ashes, and sulphur have been used with success. Sulphur may be applied dry or suspended in water.

Of liquid applications the following have proved effective: (i.) A solution of whale-oil soap in the proportion of 2 lbs. of soap to 16 gallons of water.

(ii.) An extract of wormwood, made by pouring a pailful of boiling water over a handful of wormwood and letting it stand for 12 hours.

This bitter extract renders the plants treated with it very distasteful to the beetles.

The liquid applications should be applied with a syringe, which produces a fine spray. Both liquid and dry substances should be distributed early in the morning whilst the dew is on the plants and the beetles torpid and inactive.*

The land should be kept as clean as possible, all rubbish, broken wood, &c. should be cleared away. It is possible that the beetles pass the winter in such rubbish, which should therefore be burnt or otherwise destroyed. All weeds should be removed, and it should be noted whether the beetles attack any common weed, as the Turnip flea does the Charlock, in which case special precautions should be taken for the destruction of the weed.

The roots and stems of the Rice must never be left about, as very probably the beetle passes the period which elapses between the reaping of the crop and the sowing of the succeeding one concealed in some refuse of the first crop. All such refuse should be collected and burnt.

A deep mode of cultivation is often useful, as it serves to bury the beetles and the pupæ at a depth from which they cannot escape to the surface again.

In temperate climates the *Halticidæ* can be kept away from a crop by the presence of moisture and shade, they flourish only in sunny places.

A method which has been much used in the United States, in fighting with the Grape-vine Flea beetle *Graptodera* (Haltica) *chalybea*, is to shake the beetle off the vine into pans containing kerosene or some such oil. Another method is to shake them into a piece of canvas, kept open by two sticks, one at each end, the canvas having been previously soaked in kerosene.

The kerosene kills the beetles almost at once. Smearing the pans or canvas with tar, kept moist by admixture with oil or grease, would probably serve the same purpose.

Christ's College, Cambridge,
December 15, 1888.

LXXVIII.—FIBRE FROM LAGOS.

(*Honckenya ficifolia*, Willd.)

Botanical specimens as well as a specimen of fibre were recently received at Kew through the Colonial Office from the Governor of Lagos. These specimens have proved interesting as bringing under notice, apparently for the first time, a valuable fibre-plant on the West Coast of Africa. The plant has been determined as *Honckenya ficifolia*, Willd. (Clappertonia ficifolia, *Decaisne*), a member of the natural order *Tiliaceæ*. It is fully described in Oliver, *Flora, Tropical Africa*, Vol. i. p. 260. Below will be found the official correspondence bearing on the subject, including a report of Messrs. Ide and Christie on the commercial value of the fibre :—

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* For further details of Insecticides, c.f. "Notes on Economic Entomology," No. 2, by E. C. Cotes, Calcutta, 1888.

COLONIAL OFFICE to ROYAL GARDENS, KEW.

SIR, Downing Street, 12th December 1888.

I AM directed by the Secretary of State for the Colonies to transmit to you, for your observations, a despatch from the Governor of Lagos, enclosing a correspondence with Mr. Alvan Millson respecting a local fibre-yielding plant known as "Bolobolo" or "Agbonrin Ilassa."

I am, &c.
(Signed) ROBERT G. W. HERBERT.

The Director,
Royal Gardens, Kew.

[Enclosure.]

MY LORD, Government House, Lagos, 1st November 1888.

I BEG to trouble your Lordship with a copy of the correspondence with reference to a local fibre-yielding plant known in the Popo vernacular as "bolobolo" and in Yoruba as "Agbonrin Ilassa," which has been supplied by Mr. Millson, the Commissioner of the Western District.

The correspondence covers herbarium specimens and a sample of the fibre on which this Government would be obliged to be favoured with an expression of opinion by the Director of the Royal Gardens, Kew.

I have, &c.
(Signed) C. A. MOLONEY,
Governor.

The Right Hon. Lord Knutsford, G.C.M.G.,
&c. &c. &c.

MESSRS. IDE AND CHRISTIE to ROYAL GARDENS, KEW.

DEAR SIR, 72, Mark Lane. London, E.C., 17th December 1888.

WE have your favour of the 15th instant, with specimen of "Bolobolo" fibre from Lagos. We consider this a very valuable fibre of the jute class, but distinctly superior to the latter in many respects, and more particularly in strength. It is of good length and well cleaned. If this fibre is capable of being produced in large quantities there is a very wide field open to it commercially. Its market value would be regulated by that of jute, but in our opinion it would always command a higher price. At to-day's currencies it would sell at 16*l.* per ton in London. We do not think the minimum price would ever fall below 12*l.*, and if the jute market made a further advance, this "Bolobolo" fibre might realize 20*l.* If this fibre could be prepared of a whiter colour it would prove still more acceptable; but even as it is, we should be very glad to see large quantities placed on this market, where they would sell readily.

We are, &c.
(Signed) IDE AND CHRISTIE.

D. Morris, Esq., M.A., F.L.S.,
Royal Gardens, Kew.

LXXIX.—YAM BEAN.

(*Pachyrhizus tuberosus*, Sprengel.)

In the *Kew Bulletin* for August 1887 information was given respecting the introduction of certain West Indian food-plants to the East Indies. The subjects then treated were the Tree-tomato (*Cyphomandra betacea*); the Chocho (*Sechuim edule*); the Arracacha (*Arracacia esculenta*), and the Cherimoyer (*Anona Cherimolia*).

Although not indigenous to the West Indies, the subject of the present notice has been for a long period cultivated there. Its earliest modern systematic name is *Dolichos tuberosus* (Lamarck, Dict. II. p. 296). It is figured by Plumier, *Plant. Amer.*, pl. 220; and also by Descourtilz, *Flore des Antilles* (1829), viii. p. 127, pl. 554, who states that it was grown in Martinique, and believed to have been brought from the Spanish Main by the Caribs. It was transferred from the genus *Dolichos* to *Pachyrhizus* by Sprengel (*Systema Vegetabilium*, Vol. iv., part i., p. 281). By modern writers it appears to have been included under *Pachyrhizus angulatus* D.C. (Dolichos bulbosus, *Lamarck*), from which, however, it differs by the leaves being rounded not dentate; by the white, not violet flowers; by the much larger pods; and possibly also by the seeds, which are kidney-shaped, white, black, or mottled.

A good figure of *Pachyrhizus angulatus*, to which reference may be made for purposes of comparison, appears in the *Flora Brasiliensis*, Vol. XV., pt. i., pl. 53; there is also a figure in Plumier's *Plant. Amer.*, pl. 222.

In February 1886, Dr. Ernst, of Caracas, wrote respecting some specimens he was sending to Kew, as follows:—"Is there really a "*Dolichos tuberosus* cultivated or wild in the Antilles? I have a "plant from Merida, which agrees well with Plumier's, plate 220, but "it is a *Pachyrhizus*. I see Sprengel has already reduced *D. tuber-*"*osus* to *Pachyrhizus*; but it appears that it is not generally admitted. "Grisebach speaks of *Dolichos tuberosus*, and Bentham and Hooker "(in the *Genera Plantarum*) say there are but two species of *Pachyr-*"*hizus* (*angulatus* and *palmatilobus*). Is it perhaps their opinion that "*D. tuberosus* is only a variety of *Pachyrhizus angulatus?* I send "to-day leaves, fruit, and seeds of my Merida plant. The root is "edible; it is certainly what Weddell (*Ann. Sci. Nat.*, 4, Vol. vii.) "describes under the native name of *Ahipa;* the young roots are just "as he says; when older they get much larger and lose their fusiform "ends. I should like to see the text of a good description of "*D. tuberosus*. I have only that of Lamarck."

In April 1887 seeds, under the name of *Dolichos tuberosus*, were received from Mr. J. H. Hart, F.L.S., Superintendent of the Botanical Gardens at Trinidad. These were distributed to the Botanic Gardens of Calcutta, Ceylon, Brisbane, Melbourne, Sydney, and Adelaide. The seeds sent to Ceylon were grown by Dr. Trimen, and he discovered that not only were the tuberous-like roots edible, but that the pods were a very useful vegetable. He wrote: "January 30, 1888:—Last year "you sent me some seeds of a tuberous vegetable labelled *Dolichos* "*tuberosus*. These grew well . . . . . They are quite new to "Ceylon, the vegetable being quite unknown here, and I fancy little "grown in India. The young pods, served like French beans, are an "admirable vegetable, tender and sweet; and the elongated arrowroot-"like tubercles on the roots are also good when cooked. Altogether

" the plant is a decided acquisition to the vegetable garden. The " flowers are pure white here."

Specimens of leaves, flowers and fruit were recently received from Dr. Trimen, and these, together with the specimens already received from Dr. Ernst, were sufficient to establish the fact that *Dolichos tuberosus* of Lamarck, a native of tropical South America, although hitherto included under *Pachyrhizus angulatus*, D.C., was a good species. It was decided to keep it apart under the name of *Pachyrhizus tuberosus*, Sprengel. A figure and description will shortly appear in the *Icones Plantaram*, and in the meantime it is desirable to place on record what is known of it as an economic plant.

In Jamaica it is cultivated under name of the Yam bean. The following account is given of it and its uses by Macfadyen in the *Flora of Jamaica*, p. 285:—" Flowers white. Seeds red. The root is formed " of a number of simple cord-like fibres, several feet in length, stretching " under the surface of the ground, bearing in their course a succession " of tubers. The beans are poisonous, but the root affords a very " plentiful supply of very wholesome food. The produce of three " plants is usually sufficient to fill a bushel basket. The tubers may " either be boiled plain, in which state they are a very good substitute " for yams and other roots in common use; or they may be submitted " to a process similar to arrowroot, and a starch obtained. This starch " is of a pure white, and is equal in every respect to arrowroot.

"To the taste it is very palatable, is easily digested, and is employed " for custards and puddings. Even the trash left after obtaining the " starch, and which in the preparation of arrowroot is lost, may, when " thoroughly dried, be formed into a palatable and wholesome flour. A " very excellent flour may also be obtained by slicing the tubers, drying " them in the sun, and then reducing to a powder. This plant is deserving " of being more generally cultivated than it has hitherto been. It ought " in a great measure to supersede the arrowroot in cultivation. It can be " planted at any season of the year, and the roots are fit for digging in the " course of four or five months; the return is infinitely greater than that " from arrowroot, and the proportion of starch also is more abundant, " so that it can be brought to market at so cheap a rate as to admit of " being employed by the calico printers in place of potato-starch. The " Yam bean has of late years been partially cultivated in this island. It " is said to have been introduced from Martinique."

Macfadyen, it is noticed, speaks of the seeds as being poisonous. Spruce, who collected what appears to be the same plant at Tarapota in South America, in 1857, describes it as "herba volubilis 10–20 pedalis, pro- " tuberis maximis, edulis culta." The Peruvian name is stated to be *Ashipa*, and he adds " the seeds are poisonous." It is well known that in the uncooked state the seeds of the ordinary kidney bean are said to be also poisonous. There can be no doubt whatever the Yam bean is perfectly wholesome when cooked, both as regards the pods and the root tubers. It is also perennial and altogether constitutes one of the most valuable food plants for tropical countries. In a recent letter Dr. Trimen states, "I have been having large crops of beans lately; the stems sent " up from the yams of last year bearing freely. What constitutes their " superiority over the ordinary French beans is the absence of any " fibrous string along the sutures of the pod. The large size is also " an advantage; they are often 10 or 12 inches long."

In the Museums of Economic Botany at Kew there are pods of this species from Jamaica, contributed by Mr. March, and also (with mottled seeds) from Mr. Spruce from Tarapota, Peru. There are seeds (red); specimens of dried tubers; and a specimen of starch prepared from the

tubers from Jamaica presented by Mr. D. Morris in 1883. Good specimen pods of *Pachyrhizus angulatus* are now desired in order to make he collection complete.

LXXX.—SCHWEINFURTH'S METHOD FOR PRESERVING PLANTS.

A useful method for preserving plants, especially those collected during the wet season in damp tropical forests where there are no facilities for drying paper, has been recommended by Dr. Schweinfurth, the well-known African traveller and botanist. Dr. Schweinfurth's first publication on collecting and preparing flowering plants and ferns for the herbarium appeared about 14 years ago in a book of instructions to scientific travellers (*Anleitung zu wissenschaftl. Beobachtungen auf Reisen.*) The following summary is taken from the *Bulletin of the Torrey Botanical Club* for November 1888, pp. 292–3 :—

"H. Schenck * calls the attention of collectors, especially those travelling in the tropics, to a method of preserving plants for the herbarium recommended by Schweinfurth, which he found exceedingly convenient and efficient during his travels in Brazil.

"The plants when collected are at once put between the sheets of a leather portfolio. On his return from the excursion the collector places the specimens between single sheets of common grey, unsized paper (to be had in every 'venda' in Brazil), which are firmly held together between two pieces of stout pasteboard by means of a strap. There the bundle is set upright in a tin box, and strong sugar-cane brandy or common alcohol is poured on the sheets from above, until the paper and the plants are thoroughly moistened and the liquid begins to run off below. The bundle or bundles are kept in the tightly-covered tin box until a quantity of them has accumulated. Then the straps and boards are removed, the single packages are wrapped up in paper and packed as closely and firmly as possible in a tin box about 2 feet high, which, finally, is tightly closed by soldering a flat cover to it. Several such boxes are packed in a wooden case for shipping. Some small tin boxes ought to be taken on more extended excursions.

"The preservation of plants after this method requires very little time (an advantage of the utmost importance for a traveller), for it is not necessary to arrange the specimens carefully between the sheets. The plants remain in good order, soft, pliable and moist, for years, and may be dried for the herbarium at the collector's convenience, after his return from his travels. They also remain in good condition for anatomical examination, and all kinds of flowers, as well as thick-leaved plants—such as many species of orchids, cactaceæ, &c.—will arrive at home in excellent order. Besides, plants may be collected and placed between the sheets in rainy weather."

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* In *Bot. Centralbl.*, vol. xxvv. p. 175.

LXXXI.—A STARCH-YIELDING BROMELIAD.

(*Puya edulis*, Morren.)

In arranging the drawings of *Bromeliaceæ*, and the manuscript notes relating to these plants, by the late Professor Morren, of Liege, lately acquired by the Bentham trustees, and presented by them to this establishment, a letter was found written by M. Lietze, of Rio Janeiro, in the year 1878, respecting a Bromeliad with esculent leaves. The plant to which reference is made is in cultivation in Europe, but it has not been seen by Mr. Baker, who is now engaged in monographing the family, except in a very young condition without flowers. It was published by Morren as a species of the genus *Puya*, but there can be little doubt that it is really a *Dyckia* of the species of which Central and Southern Brazil, and Uruguay are the head-quarters. Mr. Baker is of opinion that *Puya edulis*, Morren, is nearly allied to *Dyckia frigida*, Hk. f. (*Botanical Magazine*, t. 6294), of which *D. regalis*, and *Pourretia frigida* are garden names. So far as at present known, the genus *Puya* is confined to the Andine region. The following is an extract from the letter of M. Lietze :—

"Rio Janeiro, 23rd September 1878.

"I beg to tender you my warmest thanks, and I am rejoiced to be able to send you by post two packets, containing (1) a young plant of a Bromeliad from the basin of the Rio Doce; (2) seeds of the same; (3) portions of dry leaves, ready to be crushed for the extraction of the starch; (4) the same starch ready for consumption. This vegetable has saved many people, especially Indians, from dying of hunger. The specimens have travelled nearly three months, and all may be altered by the moisture.

"The species has a strong habit, as the portions of the leaves, and also an old trunk, which reached me in a rotten condition, show.

"The case presents novelty enough to me. The extraction of starch from the leafy parenchyma was strange to me, but could not be doubted. When I visited Rio Doce, the people often spoke to me of this vegetable, assuring me that the product was eagerly sought after as an article of food.

"A. Lietze."

The first description of the plant from the pen of Professor Morren appeared in *La Belgique Horticole*, 1878, p. 354 :—

"*Puya edulis* (sp. nov.). There grows in Brazil, in the province of Rio Doce, a Bromeliad which furnishes in abundance an excellent fecula. This alimentary substance accumulates in the leaves, which it is necessary to crush in order to obtain it in abundance. The plant, which has a stem, attains large dimensions. The base of the leaves, which are very spiny, measures as much as 2½ inches across. This plant has saved the lives of thousands of Indians during the famine, which has recently desolated certain provinces in Brazil. We have not seen the flowers, but to judge from the habit, and especially from the seeds, it ought to belong to the genus *Puya*."

LXXXII.—THE FRUITS OF MYSORE.

Mysore is a native state in Southern India, with Bangalore as the head-quarters of the Government. It has an estimated area of 24,723 square miles, and consists of an undulating table-land, much broken by ranges of rocky hills, and scored by deep ravines. These latter characteristics are due to the fact that it is situated in the angle where the eastern and western Ghâts converge with the group of the Nílgiri Hills. The general elevation of the country increases from about 2,000 feet above the level of the sea, along the northern and southern frontiers, to about 3,000 feet at the central water-parting which separates the basin of the Kistna from that of the Káveri.

The city of Bangalore stands in the centre of the Mysore table-land at an elevation of 3,113 feet above the level of the sea. At this elevation the climate differs very materially from that usually associated with Southern India. The mean annual temperature is 76·2 F., and the annual rainfall is 36 inches. A picturesque garden known as the Lal Bagh, or red garden, under the charge of Mr. J. Cameron, F.L.S., formerly of Kew, is one of the most attractive features of Bangalore.

Owing to the advantages of site and climate the Lal Bagh is capable of producing the vegetable products of sub-tropical countries as well as those indigenous to India. In this respect it occupies an intermediate position between the temperate and torrid zones. The climate during nine months of the year is that of the Mediterranean region, with a generous glow of the tropical sun superadded. During the remaining quarter of the year it is hot and dusty.

In continuation of the reports on tropical fruits which have already appeared in previous numbers of the *Kew Bulletin*, Mr. Cameron has been good enough to communicate the following notes on the fruits of Mysore, but with more especial reference to those growing in the neighbourhood of Bangalore:—

Anonaceæ.

Anona muricata, the Sour Sop; *A. reticulata*, the Custard Apple or Bullock's-heart; and *A. squamosa*, the Sweet Sop, are generally grown in Mysore. The Cherimoyer, *Anona Cherimolia*, has been sucessfully introduced to Southern India, but it has not yet been grown at Bangalore.

Guttiferæ

Ochrocarpus longifolius (Flora British Ind. vol. 1, p. 270) yields a fruit which deserves to be better known. It is a middling-sized tree with flowers two thirds of an inch in diameter. The fruit about an inch long, is obliquely ovoid, tipped by the hard-pointed style. [Specimens of this fruit have lately been forwarded by Mr. Cameron to the Kew Museum.]

Garcinia Mangostana, the celebrated Mangosteen of the Malayan Archipelago does not succeed in the climate of Bangalore.

Malvaceæ.

Hibiscus Sabdariffa, the Rozelle or Sorrel, yields from the succulent calyx an agreeable acid juice which is much used in preserves.

STERCULIACEÆ.

Guazuma tomentosa. This tropical American tree is widely distributed in India. Children are fond of the tubercled capsule, which resembles a mulberry. Cattle are fond of the leaves and fruit also.

MALPIGHIACEÆ.

Malpighia punicifolia, known as the Barbados Cherry, and *Malpighia glabra*, called the Surinam Cherry, are sparingly grown in Mysore, but are very rarely used. The former, especially, might be used as in the West Indies for making jams or candied with sugar.

GERANIACEÆ.

Averrhoa Carambola, known as the Kómarac, is a garden plant of considerable value. We have three varieties at Bangalore. One is comparatively sweet, and the other two are very acid. There are also differences in the size of the fruits as well as in the trees that bear them. The natives are very fond of the fruits, and a few trees in the garden are let out on contract at about 8*l.* yearly.

Averrhoa Bilimbi has a fruit with five rounded lobes. It is used almost exclusively in pickles only.

RUTACEÆ.

Clausena Wampi (*Cookia punctata*) has been recently introduced. The fruit is small and globular, with a tough rind covered with glands full of green balsamic oil.

Triphasia trifoliata. This is a spinous shrubly plant often used for hedges. The small fruits are rarely used.

Feronia elephantum, the Elephant or Wood-apple. The pulp of the fruit is edible.

Ægle Marmelos. This is the well-known Bael tree which bears a fruit varying in size from 2 to 5 inches in diameter. The rind is grey, and the pulp, considered valuable in cases of dysentery, is sweet, thick, and orange-coloured. At Bangalore there are two well-marked varieties, the large fruited and small fruited.

Citrus decumana, or Pumelo. We have four varieties of this fruit in addition to the Amoy pumelo recently introduced. The large pink-fleshed varieties are most esteemed.

Citrus Aurantium. The orange succeeds well on the hills of Mysore, but never attains perfection in the plains. There are four or five well-marked varieties of the orange known in cultivation here, including the Coorg and Nagpur oranges, which are considered the best. The St. Michael's orange is said to have been recently introduced, but I much doubt if it is true to name.

Citrus Medica. There are three varieties of the Citron known here.

Citrus Medica, var. **acida.** This is the Sour Lime of India. There are four or five kinds of the sour lime, some of which are cultivated in every town and hamlet. The fruit is offered by the Hindoos to their friends as an emblem of friendship.

Citrus Medica, var. **Limonum.** There are two well-marked Lemons known here in addition to the Malta Lemon recently introduced. We have also small plants labelled "Jamaica Lemons."

Citrus Medica, var. **Limetta.** Of the Sweet Lime we have two kinds distinguished as the round and oval.

RHAMNEÆ.

Zizyphus Jujuba. Bhere fruit. The natives appear to like this fruit, of which there are several varieties. These are distinguished by the shape of the fruit, which may be either globose or oblong. [In the *Flora of British India*, Vol. I. p. 633, it is stated that there are many cultivated varieties of *Zizyphus Jujuba*, differing greatly in the shape and size of the leaves, as also in the size and nature of the fruit, of which the most remarkable is Edgeworth's variety, *Hysudricus* (*Journ. Linn. Soc.*, vi. 201), with erect or spreading, not drooping, branches, obtuse, ovate, oblong, or orbicular leaves, glabrous, or slightly tomentose beneath, and long petioles. This, according to Aitchison, is always raised by grafts. Two other varieties are described by Edgeworth, viz., *hortensis* and *spontaneus*.]

AMPELIDEÆ.

Vitis vinifera. The Grape. There are about six varieties of the grape vine under cultivation in Mysore, including the Black Hamburg, the White Frontignan, and the Aurengabad. The latter is perhaps the best of all, but it is very liable to blight. The system of bush training practised in France has been successfully tried by a cultivator some miles from Bangalore. With suitable varieties, adapted to the soil and climate, I see no reason why India should not be able to grow her own wine. I have recently written home for a selection of the best hot-house varieties, for trial in the open air.

Vitis indica. This is an indigenous grape vine, with slender woolly stems. The fruit is globose, the size of a large currant. It is eaten only by the hill tribes.

Vitis Martini. Cochin China Vine. This is a deciduous vine, recently introduced. [See *Kew Bulletin*, vol. ii., 1888, p. 134.]

SAPINDACEÆ.

Nephelium Lit-chi. The Lit-chi. Although widely cultivated in India, this fruit is only found in a few gardens in the neighbourhood of Bangalore at present. It is an excellent fruit, and worthy of general cultivation.

Nephelium Longana. Although a native tree, it is also often cultivated. The fruit is reddish or purple, globose, about $\frac{3}{4}$ inch in diameter, and, like the Lit-chi, it posseses a wholesome edible aril.

ANACARDIACEÆ.

Spondias mangifera. Hog-plum of Europeans and Amra of the Hindoos. This is a drupaceous fruit $1\frac{1}{2}$–2 inches long, yellow, smooth; the flesh is austere, and on this account it is rarely used as a dessert fruit. The natives usually parboil it with other ingredients of their food. A species of *Spondias*, whose name is unknown, has a larger fruit than the Hog-plum. In other respects it is very similar.

Anacardium occidentale. Cashew nut. The kidney-shaped nut is generally used roasted. The pyriform fleshy receptacle about 2–3 inches long has a pleasant acid astringent flavour, which is liked by many people.

Mangifera indica. The Mango. This fruit in India has been greatly improved during the past quarter of a century by the process known as inarching, and, during the last two hundred years, by careful selection of seed. The seedling plants run to endless varieties

as affected by cross-fertilization, soil, and climate. In most parts of the country the best of these are now fixed by the process of inarching. The names given to good kinds are usually derived from the places where they are grown or have reference to the persons who were concerned with them. In addition to a large number of varieties, we have the following named sorts at Bangalore:—

Alfonso, a small-fruited kind from the Portuguese settlement of Goa.

Bangalore, a small fruited mango associated with this district.

Goa, a large fruited mango, considered one of the best.

Bavadeen, introduced from Chitoor. It is a long fruited mango, pointed at both ends.

Salem, called after the town of that name, and esteemed as a good fruit.

Oothamavencemara, one of the largest mangoes.

Raspberry, so named perhaps on account of its colour, which is a bright rosy red on one side when ripe.

Badami, is an almond-flavoured mango.

Peter, *Thillpassand*, *Dudipada*, *Gathaymar*, and *Chittoor* are very superior mangoes grown at such places as Bombay, Malda, Mogazon, Chittoor, Salem, and Bangalore, but when removed from their native localities these celebrated varieties often lose their best qualities.

Leguminosæ.

Arachis hypogæa. Ground-nut. Being a common field crop the ground-nut is much eaten by the natives. Roasted, they are a good substitute for the almond.

Pithecolobium dulce. This is a native of Tropical America cultivated in India often as a hedge plant. The pod is 4–5 inches long inside of which the seeds are enveloped in a pulpy white edible aril. This pulpy aril is eaten by the poorer classes.

Ceratonia Siliqua. The Carob tree. The trees in the Lal Bagh fruit freely.

Rosaceæ.

Prunus Persica. The Peach. The peaches in this country are vastly inferior in size and flavour to the fruit grown under glass in Europe. Varieties such as the Noblesse and Barrington have been tried, and although the plants flourish fairly well they have never, as far as I am aware, borne fruit. Experiments are in course of being tried to graft choice sorts on naturalised stocks. Our present supplies of peach fruits are maintained from an inferior sort called the "country peach," and from a variety known as the "Indore peach." The nectarine (which is regarded as a form of peach with a smooth and not downy skin) is also grown, and fruits freely.

Prunus Armeniaca. The Apricot. The apricot is cultivated and almost naturalised in mountainous parts of India. It succeeds also in the hills around Bangalore.

Prunus communis. The Plum. Two varieties known as Keikes and Magnum Bonum are principally under cultivation here. They succeed only fairly well.

Rubus rosæfolius? There is here a cultivated bramble which is neither the blackberry nor the raspberry. It seems to be intermediate between these two. When the plants are well managed the fruit is excellent.

Fragaria vesca. The Strawberry. There are several varieties of the Strawberry under cultivation, one from Australia being the most prized at present. The Strawberry plant has to be treated as an annual on the plains of India, otherwise its produce would scarcely be worth collecting in the second year. We plant out strong off-sets in August which begin to fruit in the following January or six months from the time of planting. The fruiting season is usually over by the middle of March.

Eriobotrys japonica. The Loquat. There are two varieties of this plant, one recently introduced from the north of India yields an excellent fruit.

Pyrus communis. Pear. As a dessert fruit the Pear is said to attain a certain degree of perfection at Ootacamund. Here we have only two varieties of a tasteless cooking pear.

Pyrus Malus. Apple. A good many native families make their living by growing apples in this district. It is surprising to see what excellent fruit they raise from small stunted bushes, native grown. Apples when very scarce sell at the rate of about Rs. 3 to Rs. 4 per dozen (4*s.* 6*d.* to 6*s.* per dozen). The plants never become trees, as may easily be imagined when the natives plant them only 4–5 feet apart. There are about 20 varieties, including Ribston Pippin, Dutch Codlin, and other well-known kinds. Amongst the natives they are universally known by their numbers only.

COMRRETACEÆ.

Terminalia Catappa. Country Almond. The large almond-like seeds, are eaten both in the raw state and roasted. In the latter condition they are very palatable and afford a good substitute for almonds.

MYRTACEÆ.

Psidium Guyava. Guava. This is naturalised throughout India. There are two well-marked varieties: var. *pyriferum* with one-flowered penduncles and fruit pear-shaped; var. *pomiferum*, with two or three flowered penduncles and fruit globose or ovoid. The process of inarching has done much to improve this fruit, of which there are under cultivation several varieties. Indians and Eurasians are exceedingly fond of this fruit, which they often eat when quite green.

Eugenia Jambos. Rose apple. The flowers of this are large and white, while the fruit is sub-globose and slightly scented.

Eugenia malaccensis. Malay apple. The flowers of this are red. The fruit is oval and of a beautiful rosy-pink colour. There are several varieties under cultivation, of which one has an avoid dark purple fruit.

Eugenia myrtifolia. This is a shrub or small tree which yields a small and palatable fruit.

Eugenia Jambolana. Jamoon. There are several varieties of this fruit, varying in size from that of a pea to a pigeon's egg. The best is that with large fruits usually produced in fine clusters. A model of the latter may have been observed at the Indian Court of the Colonial and Indian Exhibition of 1886. The tree attains a large size, and is usually found in village topes as well as at road-sides.

LYTHRACEÆ.

Punica Granatum. Pomegranate. This fruit is much prized by Mahommedans, and is chiefly cultivated by them. There are four varieties, of which the large red is considered the best.

CACTEÆ.

Opuntia, spp. Prickly Pears. There are several kinds of Prickly Pears grown in India for the sake of the fruits. Some plants (possibly *Opuntia Ficus-indica*) have lately been brought from Malta. [On Prickly Pears in India and the principal species cultivated in the Mediterranean region see *Kew Bulletin*, 1888, pp. 170–171.]

RUBIACEÆ.

Canthium parviflorum. This is a rigid shrub covered with stout straight spines. The fruit has an agreeable acid taste, and is eaten by children.

SAPOTACEÆ.

Achras Sapota. Sapodilla-plum. This West Indian fruit tree is only cultivated so far in the Botanical Gardens. There are two varieties, viz., the round and oval-fruited Sapodilla.

OLEACEÆ.

Olea europæa. The Olive. This has been cultivated in the Botanic Gardens for 20 years, but has never fruited.

APOCYNACEÆ.

Carissa Carandas. Karinda. The fruit of this small tree is a drupe ½–1 inch long, at first red, then black and polished. In the wild state it is not unpleasant, and it might be improved and rendered of great value by cultivation.

SOLANACEÆ.

Cyphomandra betacea. Tree-tomato. This valuable introduction to Southern India (*Kew Bulletin*, August 1888, p. 2) has been established at Bangalore and fruited several times. On the Nilgiris also it has been very successful, and the fruit pronounced "most delicious." Directions for the treatment of the plant and various ways for using the fruit are contained in the recently issued volume of the *Proceedings Agri-Horticultural Society of Madras* (New Series, Vol. iv., 1885–86–87).

LAURINEÆ.

Persea gratissima. Alligator Pear. This is a comparatively rare plant under cultivation here.

EUPHORBIACEÆ.

Antidesma sp. A plant of this genus, whose specific name I am unable to determine, affords a berried fruit resembling a miniature apple.

Cicca disticha. Star-gooseberry. The fruits of this tree are like those of the gooseberry, three or five-furrowed and some acid and cooling. They are used either in a raw state or cooked in various ways.

Phyllanthus Emblica. This is a tree sometimes of large growth. The fruit is obscurely six-lobed, and resembles a gooseberry. It is exceedingly acid, and is used in pickles and preserves.

URTICACEÆ.

Artocarpus incisa. Bread-fruit. We have two varieties of the bread-fruit, the seeding and the seedless. The latter flourishes on the western coast, but is not likely to succeed on the inland plains of India. Of the seeding fruit there are several sub-varieties, one of which fruits regularly at Bangalore.

Antocarpus integrifolia. Jack-fruit. The Hindoos are exceedingly fond of this fruit, of which there are numerous local varieties. A native nobleman (the Jaghirdar of Arnee) cultivates 40 distinct varieties of Jack-fruit, each tree being carefully numbered according to the quality of the fruit yielded by it. The fruits which grow upon the root-stock are highly prized. A large-sized Jack-tree in full bearing is one of the grandest sights in the vegetable kingdom.

Morus alba. White Mulberry.
Morus nigra. Black Mulberry.
Morus indica. Indian Mulberry.
Morus japonica. Large-fruited Mulberry.

All these are sparingly cultivated for the sake of their fruits, but the first, second, and third are extensively grown for feeding silkworms.

Ficus Carica. Fig. There are several varieties of figs grown in India, but none of them attain that degree of perfection which the climate would seem to indicate. The fig is one of the dessert fruits regularly and almost exclusively grown for the European population at Indian stations. When well-ripened the good varieties are far preferable to any preserved figs I have ever tasted.

Ficus glomerata. Country Fig. This is a native species, which yields an abundant quantity of an inferior fruit. It is eaten only by the hungry and poor.

Ficus Roxburghii. This is another native fig, but the fruit is not much eaten.

SCITAMINEÆ.

Musa sapientum. Plaintain [or Banana]. Of all the fruits grown in India this is the most prolific and most useful. There are numerous varieties, of which the following are the vernacular names of the most prominent in this district :—

Yáláki bále - -	Large-fruited plantain.
Ælle bále - - -	The foliage plantain.
Gulur bále - -	Small butter plantain.
Gulur dodda bále - -	Large butter plantain.
Rasa bále - -	Custard plantain.
Havu bále - -	Snake plantain.
Putta bále - -	Guindy plantain.
Chanava bále - -	Red plantain.
Jain bále - -	Honey plantain.
Raja bále - -	Custard plantain.
Pacha bále - -	Large green plantain.
Yalaki bále - -	The small plantain.

BROMELIACEÆ.

Ananas sativa. Pine-apple. This succeeds fairly well with careful and rich treatment. We are in want of the best varieties.

PALMÆ.

Cocos nucifera. Cocoa-nut. At an elevation of 3,000 feet and 200 miles from the sea the Cocoa-nut palm is scarcely worth cultivating. It is, however, here and there in several varieties. [In other parts of Mysore, especially when water is near the surface, the cultivation of the Cocoa-nut is said to be fairly profitable. The export of fresh Cocoa-nuts from Mysore State in 1880–81 was valued at 10,452*l.*, and of Cocoa-nut oil at 666*l.* *Imp. Gaz. of India*, vol. x. p. 102.]

Phœnix dactylifera. Date-palm. This has only been recently introduced. The Wild Date (*Phœnix sylvestris*), on account of the toddy yielded by it, is one of the most valuable trees in Mysore.

Since the above information was prepared by Mr. Cameron there has been issued the Annual Report on the Government Botanical Gardens at Bangalore for 1887–88 which contains much useful information.

It appears that the Tree-tomato, *Cyphomandra betacea*, the Arracacha, *Arracacia esculenta*, and the Cho-cho, *Sechium edule*, three very important food plants introduced to the East Indies through the instrumentality of Kew and the Botanical Gardens at Jamaica, have now been successfully established at Bangalore. Various new varieties of grape vines, apples, apricots, nectarines, peaches, plums, raspberries, and the Spanish chestnut, have been introduced during the past year, and these it is proposed to cultivate in the Palace Gardens. It is stated that 690 off-sets of the date palm and 164 pounds of date palm seed had been received. The result of experimental cultivation of this plant so far has not proved satisfactory. Some of the off-sets received from the Persian Gulf cultivated in the garden afford some hope of doing better in the future.